IS 1024 (1999): Code of practice for use of welding in bridges and structures subject to dynamic loading [MTD 12: Welding Applications]

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भारतीय मानक

गत्यात्मक भार से प्रभावित पुलों और संरचनाओं में वेल्डन का उपयोग – रीति संहिता

(दूसरा पुनरीक्षण)

Indian Standard

USE OF WELDING IN BRIDGES AND STRUCTURES SUBJECT TO DYNAMIC LOADING — CODE OF PRACTICE

(Second Revision)

ICS 25.160.10; 93.040

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February 1999 **Price Group 7**

Welding Applications Sectional Committee, MTD 12

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Welding Applications Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1968 and subsequently revised in 1979. While reviewing the standard in the light of experience gained during these years, the Committee decided to revise it to bring in line with the present practices being followed by the Indian Industry.

In this revision following changes have been made:

a) Scope of standard has been modified by including manual, semi-automatic and automatic metal arc welding processes.

b) References to Indian Standards have been updated.

c) Details of welding consumables have been added.

d) Design of welded joints and welding procedures have been modified.

e) Welding in solid web girders have been included.

In this revision, assistance has been derived from the following:

a) BS : 153 Parts 3 B and 4 B : 1972 'Specification for steel girder bridges, Part 3B Stresses, and Part 4B Design and construction', issued by the British Standards Institution.

b) Welded Bridge Code, 1972 'Code of practice for metal arc welding in mild steel bridges carrying rail, rail-cum-road or pedestrian traffic', issued by Indian Railways.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

USE OF WELDING IN BRIDGES AND STRUCTURES SUBJECT TO DYNAMIC LOADING — CODE OF PRACTICE

(Second Revision)

1 SCOPE

1.1 This standard covers the use of manual, semi-automatic and automatic metal-arc welding processes in the fabrication of steel bridges and structures subject to dynamic loading by welding.

1.2 This standard also applies to the design, different stresses to be considered for the design, and construction of the bridges.

1.3 The welding procedure for this standard shall apply to IS 9595:1996 'Metal arc welding of carbon and carbon manganese steels—Recommendations (*first revision*)'.

1.4 All the provisions stated for the inspection of welds in IS 822:1970 'Code of procedure for inspection of welds', shall be applicable in conjunction with the provisions of this standard.

2 REFERENCES

The following Indian Standards contain provisions which, through reference in this test constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
307 : 1966	Carbon dioxide (*second revision*)
812 : 1957	Glossary of terms relating to welding and cutting of metals
814 : 1991	Covered electrodes for metal arc welding of structural steel (*fifth revision*)
822 : 1970	Code of procedure for inspection of welds
1395 : 1982	Low and medium alloy steel covered electrodes for manual metal arc welding (*third revision*)
2062 : 1992	Steel for general structural purposes (*fourth revision*)
3613:1974	Acceptance tests for wire — flux combinations for submerged arc welding of structural steels (*first revision*)
4353 : 1995	Submerged arc welding of mild steel and low alloy steels — Recommendations (*first revision*)
5760 : 1983	Compressed argon (*first revision*)
6419 : 1996	Welding rods and bare electrodes for gas shielded arc welding of structural steel (*first revision*)
7280 : 1974	Bare wire electrodes for submerged arc welding of structural steels
7307 (Part 1) : 1974	Approval tests of welding procedures: Part 1 Fusion welding of steel
7310 (Part 1) : 1974	Approval tests for welders working to approved welding procedures: Part 1 Fusion welding of steel
7318 (Part 1) : 1974	Approval tests for welders when welding procedure approval is not required: Part 1 Fusion welding of steel
8500 : 1991	Structural steel-microalloyed (medium and high strength qualities) (*first revision*)
9595 : 1996	Metal arc welding of carbon and carbon manganese steels — Recommendations (*first revision*)
10178 : 1995	CO_2 gas shielded metal arc welding of structural steels — Recommendations (*first revision*)

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 812 shall apply.

4 MATERIALS

4.1 Steel

All steels for the fabrication of structural members, connections and sections shall be of weldable quality conforming to IS 2062, IS 8500 and its equivalent having a maximum carbon equivalent of 0.53 when calculated by using the formula:

$$\text{Carbon equivalent} = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

4.2 Welding Consumables

4.2.1 *Electrodes for Manual Metal Arc Welding (MMAW)*

Covered electrodes shall conform to IS 814 and IS 1395 as appropriate.

4.2.2 *Wire and Flux for Submerged Arc Welding (SAW)*

Filler wires shall conform to IS 7280. The wire and flux combination shall conform to IS 3613 and IS 4353, as appropriate.

4.2.3 *Filler Rods, Wires and Shielding Gases for Gas Shielded Metal Arc Welding (GMAW)*

The filler rods or wire for shielded procedure shall conform to IS 6419. Electrodes for unshielded or self shielded procedures are generally of the cored type and shall deposit weld metal with mechanical properties not less than those specified as satisfactory for the particular grade of steel being welded. The shielding gases may be argon conforming to IS 5760 or CO_2 conforming to IS 307. The use of gas mixture is permissible, provided they have been proved to be satisfactory. When a gas mixture is used which has specified additions, the variation of such additions shall not exceed ± 10 percent of the stated.

5 FLUCTUATION OF STRESSES (FATIGUE)

5.1 General

All structural details shall be designed to avoid, as far as possible, stress concentrations likely to result in excessive reduction of the fatigue strength of members or connections. Care shall be taken to avoid sudden change of shape of a member or part of a member, especially in regions of tensile stress or local secondary bending, and steps shall be taken to avoid aerodynamic and similar vibrations.

5.2 Loads and Stresses to be Considered

Working stresses shall be reduced, where necessary, to allow for the effects of fatigue. Allowance for fatigue shall be made for combinations of stresses due to dead load, live load, impact, lurching and centrifugal force, including secondary stresses due to eccentricity of connections and off-joint loading in latticed structures. Stresses due to wind, temperature and longitudinal and nosing force, and secondary stresses due to elastic deformations and joint rigidity, may be ignored in considering fatigue.

5.2.1 Elements of a structure may be subjected to a very large variety of stress cycles varying both in range (f_{Min}/f_{Max}) and in magnitude. f_{Max} of maximum stress. Each element of the structure should be designed for the number of cycles of different magnitudes of stress to which that element is liable to be subjected during the expected life of the structure. The number of cycles of each magnitude should be estimated by the engineer in the light of cycles of each magnitude should be estimated by the engineer in the light of available data regarding the probable frequency of each type of loading.

5.2.2 In order to allow for the effect of fatigue the procedure set down in **5.3** shall be followed, using the information supplied in Tables 1 to 7. These tables give the maximum allowable stresses f for different values of f_{Min}/f_{Max} and N, or conversely, values of N for different values of f_{Max}. The notations used represent the following:

f = maximum allowable tensile or compressive working stress,

f_{Min} = minimum stress in the element during a particular stress cycle,

f_{Max} = maximum stress in the element during the same stress cycle, and

N = allowable number of repetitions of this stress cycle.

5.3 Allowable Working Stresses

5.3.1 In the case of members subjected to a number of repetitions n, of a single stress cycle, the allowable working stresses shall be those given in Tables 1 to 7, taking $n = N$ and $f_{Max} = f$. In such cases, if the stress level of f_{Max} is smaller than the allowable stress f specified for 10^7 cycles, fatigue need not be considered.

5.3.2 In the more general case of members subjected to a stress spectrum, that is to number of cycles, n_1, n_2, etc, different maximum stress levels f_1, f_2, etc, or of different ratios of f_{Min}/f_{Max} or both, the following design method shall be used:

a) All cycles with a maximum stress equal to or lower than the allowable stress quoted for Class G type connections in Table 7 for 10^8 cycles and for the relevant ratio of f_{Min}/f_{Max} shall be ignored.

b) Where the loading conditions do not give rise to groups of clearly defined stresses, all stresses greater than the allowable stress obtained from Table 7 – Class G, as defined in (a), shall be divided into atleast five selected representative stress levels approximately equally spaced between the minimum and the maximum of the stresses to be considered.

c) For each of the stress cycles the maximum allowable number of cycles N_1, N_2, etc, shall be determined from Tables 1 to 7 by interpolating the values, if necessary.

NOTE — If the stress level under consideration f_{Max} is smaller than the allowable working stress f specified for 10^8 cycles, the relevant value of N may be found by extrapolating the design tables for the particular detail and value of f_{Min}/f_{Max} by means of the formula:

$$\mathrm{Log}_{10} N = \frac{\mathrm{Log}_{10} f_8 - \mathrm{Log}_{10} f_{Max}}{\mathrm{Log}_{10} f_7 - \mathrm{Log}_{10} f_8} + 8$$

where f_7 and f_8 are the allowable stresses for 10^7 and 10^8 cycles respectively, as given in Tables 1 to 7.

d) Designating the expected number of cycles for each stress level n_1, n_2, etc, the element shall be designed so that:

$$\frac{n_1}{N_1} + \frac{n_2}{N_2} + \ldots\ldots\ldots\ldots \frac{n_n}{N_n} > 1$$

5.3.3 Under no circumstances shall the basic permissible stresses given in the relevant Indian Standard Specifications for the particular type of structure or lower stresses required by other clauses in such standards be exceeded.

5.4 Classes of Construction Details

In Tables 1 to 7 the values of allowable working stresses are given separately for the classes of details stated below:

a) *Class A*

Members fabricated with continuous full penetration longitudinal or transverse butt welds with the reinforcement dressed flush with the plate surface and the weld proved free from defects by non-destructive examination, provided also that the members do not have exposed gas cut edges.

Welds shall be dressed flush by machining or grinding, or both, which shall be finished in the direction parallel to the direction of the applied stress.

b) *Class B*

1) Members fabricated with continuous longitudinal butt welds with full penetration made with either submerged or gas shielded metal arc automatic process but with no intermediate start-stop positions within the weld length.

2) Members fabricated with continuous longitudinal fillet weld made with either submerged or gas shielded metal arc automatic process but with no intermediate start-stop positions within the weld length.

NOTE — If a 'stop' should accidentally occur in a weld which is supposed to be free of start-stop positions, the weld crater shall be chipped or machined back in the form of a taper over a length of at least eight times the weld size, and the weld shall then be restarted at the top of the tapered slope. On completion, the surface of the weld at the start-stop position shall be ground smooth. The object of this procedure is to eliminate the possibility of lack of fusion or trapped slag at the weld root and a change of shape of longitudinal surface profile of the weld.

c) *Class C*

Members fabricated with continuous longitudinal butt welds including fabricated beams with full web penetration of the web to flange welds, with start-stop position within the length of the weld.

d) *Class D*

1) Members fabricated with full penetration transverse butt welds made in the shop by manual welding with electrodes other than deep penetration electrodes, provided that all runs are made in the down hand position and that there is no undercutting. This does not include welds made on a backing strip if the backing strip is left in position.

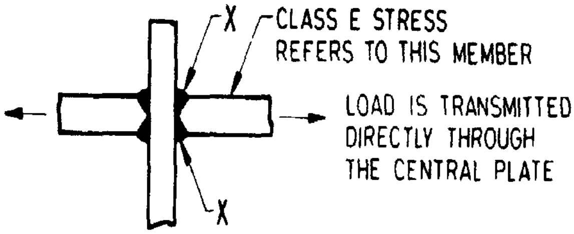
2) Members fabricated with full penetration transverse butt welds, other than those in (1), and having the weld reinforcement dressed flush and with no undercutting.

3) Members with continuous longitudinal fillet welds with start-stop position within the length of the weld.

e) *Class E*

1) Members fabricated with transverse butt welds, other than those mentioned in **5.4**(d), or with transverse butt welds made on a backing strip.

2) Members fabricated with full penetration cruciform butt welds (*see* Fig.1).



NOTE — The stresses to be considered are in all cases the nominal stresses at the points marked 'X'.

FIG. 1 CLASS E FULL PENETRATION CRUCIFORM BUTT WELD

f) *Class F*

1) Members with T type full penetration butt welds (*see* Fig. 2).

2) Members with intermittent longitudinal or transverse non-load carrying fillet or butt welds, except for the details covered in Class G (*see* Fig. 2).

3) Members connected by transverse load carrying fillet welds, except as shown in Fig. 3.

4) Members with stud connectors.

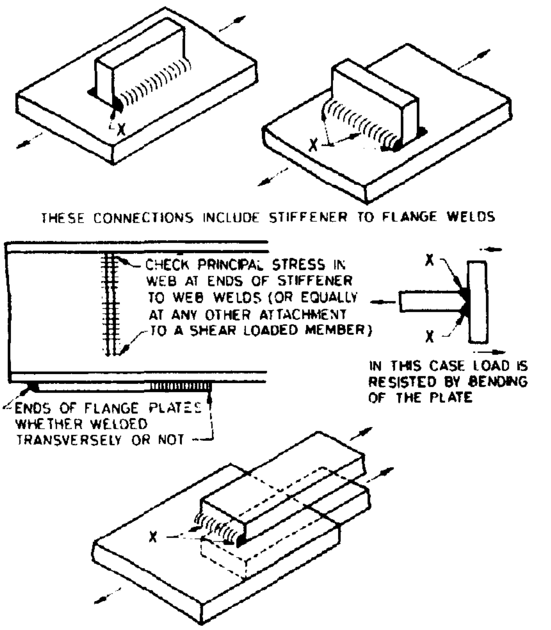
g) *Class G*

1) Members connected by longitudinal load carrying fillet welds (*see* Fig. 3A).

2) Members connected by load carrying cruciform fillet welds (*see* Fig. 3B).

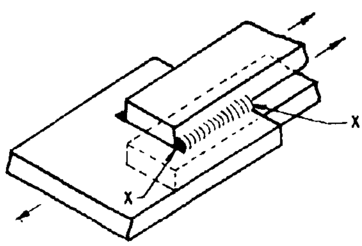
3) Members with intermittent non-load carrying fillet or butt welded attachments on or adjacent to their edges (*see* Fig. 3C).

NOTE — In Classes F and G, a weld is considered as load-carrying, with respect to the member under consideration, if it transmits a major part of the total load in the member.

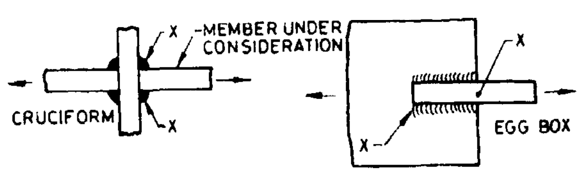


NOTE — The stresses to be considered are in all cases the nominal stresses at the points marked 'X'.

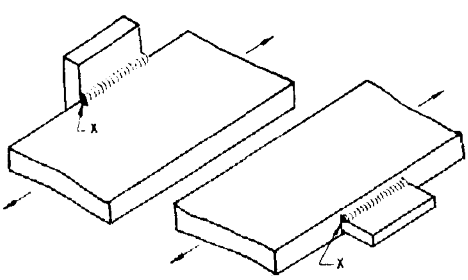
FIG. 2 TYPICAL CLASS F WELD DETAILS



3A Longitudinal Load Carrying Fillet Welds



3B Load Carrying Longitudinal and Transverse Fillets



3C Fillet or Butt Welds on or Adjacent to the Edges of Stress Plates

NOTE—The stresses to be considered are in all cases the nominal stresses at the points marked 'X'.

FIG. 3 TYPICAL CLASS G WELD DETAILS

5.4.1 Except where specifically stated to the contrary, the allowable stresses for any particular detail are the same for both mild and high tensile steel. However, the allowable working stress under fatigue may exceed the basic permissible stress for mild steel, in which circumstances high tensile steels may be advantageous.

In designing for fatigue conditions, the classes of weld should be clearly specified. Where the class of weld is not specified, the welding procedure should be agreed by the engineer.

5.5 Load Carrying Fillet Welds

These welds shall be designed such that the stress on the total effective area of fillet welds does not exceed the relevant figures given in Table 7 for Class G welds.

6 BASIC PERMISSIBLE STRESS IN WELDS

6.1 General

The permissible stress shall in no case exceed the stresses permitted in the relevant Indian Standard Specifications. Since fatigue strength of welded structures depends upon the constructional details, these shall be decided before the permissible stresses and consequently the size of members and weld sizes are determined.

6.2 Stresses due to dead load, live load and impact, stresses resulting from curvature and eccentricity of track (in case of Railways) and secondary stresses only shall be considered for effects due to fatigue.

6.3 Butt Welds

Butt welds shall be treated as parent metal with a thickness equal to throat thickness, and the stresses shall not exceed those in the parent metal.

6.4 Fillet Welds

The basic permissible stress in fillet welds based on a thickness equal to the throat thickness shall be 100 N/mm^2.

6.5 Load carrying fillet welds in dynamically loaded structures shall be designed so that the secondary bending stresses are not introduced (for example, single lap joints shall not be used).

6.6 The permissible stresses for field welds of structural members shall be reduced to 80 percent of those specified in **6.3** and **6.4**. Field welds shall not be adopted for bridges carrying road/railway loadings without the specific approval of competent authority.

6.7 If over-head wélds are unavoidable, the stresses permitted shall be 80 percent of those specified in **6.3** and **6.4** and modified by **6.6**, if field welding is involved.

6.8 In structures subjected to dynamic loading, tensile or shear stresses in butt welds shall not exceed 66 percent of the permissible stresses as specified in **6.3**

and as modified by **6.6** and **6.7** as applicable, unless the welds are examined by suitable NDT technique.

7 COMBINED STRESSES

7.1 Working stresses as given in **5.3** are the principal stresses at the point under consideration. The stresses arising from combinations of bending, bearing and shear stresses are calculated as given in **7.2** and **7.3**.

7.2 Shear and Bending Stresses

The equivalent stress f_e due to a combination of shear stress f_q and bending stress f_{bt} tensile, or f_{bc} compressive shall be calculated from:

$$f_e = \sqrt{(f_{bt}^2 + 3f_q^2)} \quad \text{or} \quad \sqrt{(f_{bc}^2 + 3f_q^2)}$$

7.3 Shear, Bearing and Bending Stresses

The equivalent stress f_e due to a combination of shear stress f_q, bearing stress f_b and bending stress f_{bt} tensile or f_{bc} compressive is calculated from:

$$f_e = \sqrt{(f_{bt}^2 + f_b^2 + f_{bt}\, f_b + 3f_q^2)} \quad \text{or} \quad \sqrt{(f_{bc}^2 + f_b^2 - f_{bc}\, f_b + 3f_q^2)}$$

7.4 Irrespective of the permissible increase of stress given in the relevant standards, the equivalent stress f_e calculated as in **7.2** and **7.3** shall not exceed 0.9 F_y where F_y is the yield strength of the steel. For convenience, values of the f_e for steels conforming to IS 2062 and IS 8500 are given below:

Steel Conforming to	F_y MPa	f_e MPa
IS 2062	230	215
	240	225
	250	230
IS 8500	280	245
	330	295
	340	310
	350	330

8 DESIGN OF WELDED JOINTS

8.1 Dynamic loads may be repetitive, fluctuating or reversible. The factors to be considered in the design of members and welded joints are:

a) number of loading cycles, and

b) constructional details like arrangement and location of joints, form of the joints, contours and finish of welds.

8.1.1 Stress raisers, such as excessive or inadequate reinforcement, sharp re-entrant angles, sudden change of sections, accidental dents, arc strikes, welded attachments in highly stressed zones, angular notches, rough flame cut edges, undercutting in welding, slag inclusions and incomplete penetrations, will cause reduction in fatigue strength. Such stress raisers should, therefore, be avoided where such reduction in strength may cause failure of the structure.

8.2 The design of welds shall generally be in conformity with IS 9595.

8.2.1 While designing welded joints, attention shall be paid to the following points:

a) Intersection of welds shall be avoided,

b) Edge preparation for butt welding should be designed with a view to using minimum weld metal so as to minimize locked-up stresses,

c) Fillet welds carrying longitudinal shear shall not be larger in size than is necessary from design considerations,

d) Deep penetration fillet welds shall be used in preference to normal fillet welds (*see* **8.4.2**), and

e) Where welded attachments in heavily stressed zones are unavoidable, the weld profile shall merge smoothly into the parent metal.

8.3 Butt Welds

8.3.1 In case of butt welds, if there is a reduction in the allowable working stress as specified in **6.3**, consideration shall be given to locate the butt welded joints away from the heavily stressed zone so as to avoid, or reduce any increase in the size of the member.

8.3.2 All details of butt welded joints shall be in accordance with IS 4353, IS 9595 and IS 10178 as applicable. Intermittent butt welds as well as incomplete penetration/fusion butt welds shall not be used.

8.3.3 Where a packing is used between two parts, the packing and the welds connecting it to each part shall be capable of transmitting the loads between the parts except where the packing is too thin to carry the load or permit the provision of adequate welds, when it shall be trimmed flush with the edges of the narrower part and the load shall be transmitted through the welds alone, the welds being increased in size by an amount equal to the thickness of the packing.

8.3.4 Sufficient convexity not exceeding 3 mm, shall be provided as reinforcement to ensure full cross sectional area at the joint. However where a flush surface is required, the butt welds shall be flushed dressed.

8.3.5 Butt joints between parts of unequal cross section arranged in line will result in a local increase in stress in addition to stress concentration caused by the profile of the weld itself. If the stresses induced by these effects are unacceptable, the parts should be shaped so as to reduce the stresses. Where the difference in thickness of the parts exceed 25 percent of the thickness of the thinner part or 3 mm whichever is greater, the dimensions of the wider or thicker part shall be reduced at the butt joints to those of the smaller part, the slope being not steeper than 1 in 5.

8.4 Fillet Welds

8.4.1 In case of fillet welds, where reduction in working stress in weld results in larger welds, consideration shall be given to shift the joint in order to avoid or reduce the stress.

8.4.2 A normal fillet weld is one in which the depth of penetration beyond the root is less than 2.4 mm, while a deep penetration fillet weld is one in which the depth of penetration beyond the root is 2.4 mm or more.

8.4.3 Normally both the leg lengths shall be equal and the size of the normal fillet shall be taken as the minimum leg length, while the size of a deep penetration fillet weld shall be taken as the minimum nominal leg length plus 2.4 mm. The minimum size of the first run of a single run fillet weld shall be as given in Table 8 to avoid the risk of cracking in the absence of preheating.

8.4.4 The effective throat thickness of a flat or convex fillet weld connecting parts, the fusion faces of which form an angle between 60° and 120°, may be derived by multiplying the leg length by the appropriate factor as follows:

Angle Between Fusion Faces Degree	*Factor by which Leg Length is Multiplied to Give Effective Throat Thickness*
60-90	0.70
91-100	0.65
101-106	0.60
107-113	0.55
114-120	0.50

8.4.5 The effective length of fillet weld shall be taken as the overall length less twice the leg length, thereby discounting the contribution of the stop and start positions which are generally of reduced profile. In any case, the effective length shall not be less than four times the leg length, subject to a minimum of 40 mm. Fillet welds terminating at the ends or sides of parts shall be returned continuously around the corners for a distance of not less than twice the leg length of the weld unless access or the configuration render this impracticable. This procedure is particularly important for fillet welds on the tension side of parts carrying a bending load. The weld shall be of full size throughout, and defect free.

8.4.6 For critical applications, the use of full penetration fillet weld shall be considered. In fillet welded joints carrying a compressive load, it shall not be assumed that the parts joined are in contact under the joint. Fillet welds at right angles to the lines of principal stress in a plate subject to tension shall be avoided in dynamically loaded structures.

8.4.7 If side fillets alone are used in end connections, the length of each side fillet shall not be less than the distance between the fillets. Side fillets may be either at the edges of the members or in slots or holes. The weld shall be of full size throughout and defect free.

8.5 Intermittent Fillet Welds

8.5.1 Intermittent fillet welds shall not be used for dynamic loaded structures, except for connecting intermediate stiffeners to webs of beams and girders. It may be used in structures not subjected to transfer calculated stress across a joint when the strength required is less than that developed by a continuous fillet weld of the smallest allowable size for the thickness of the part joined.

8.5.2 Intermittent fillet welds shall not be used where they would result in the formation of rust pockets.

8.5.3 The distance along an edge of a part between effective lengths of consecutive intermittent fillet welds, whether the welds are in line or staggered on alternate sides of the edge, shall not exceed 12 times the thickness of the thinner part when in compression or 16 times the thickness of the thinner part when in tension, and shall in no event exceed 200 mm.

8.5.4 Where intermittent fillet welds are used to form T joints, the thickness referred to above shall be that of the Table 8. In a line of intermittent fillet welds, there shall be a weld at the ends of the part connected, for welds staggered along two edges this shall apply to both edges.

8.5.5 In built-up members in which plates are connected by intermittent fillet welds, continuous side fillet welds shall be used at the ends for a length not less than the width of the plate concerned.

8.6 T Butt Joints

Butt welds in T joints shall be completed by means of fillet welds each having a size not less than 25 percent of the thickness of the outstanding part.

8.7 Fillet Welds Applied to the Edge of a Plate or Section

8.7.1 Where a fillet weld is applied to the square edge of a part, the specified size of the weld shall generally be at least 1.5 mm less than the edge thickness, in order to avoid melting down of the outer corner.

8.7.2 Whereas fillet weld is applied to the rounded toe of a rolled section, the specified size of the weld shall generally not exceed 3/4th of the thickness of the section at the toe.

8.7.3 Where a fillet weld equal in size to the thickness of the section at the toe of a rolled section or at the square edge of a plate is required from design consideration and is specially designated in the drawing, the toe or edge shall be specially built up with weld metal in such a manner as to ensure full throat thickness, full fusion area and no injury to the parent metal.

8.8 Fillet Welds in Slots or Holes

8.8.1 When welding inside a slot or a hole, in a plate or other part, in order to join the same to an underlying part, fillet welding may be used along the wall or walls of the slot or the hole, but the latter shall not be filled with weld metal or partially filled in such a way as

to form a direct weld metal connection between opposite wall.

8.8.2 The dimensions of the slot or hole shall comply with the following limits in terms of the thickness of the steel part in which the slot or hole is formed.

a) The width or diameter to be not less than three times the thickness or 25 mm whichever is greater;
b) Corners at the enclosed ends of slots to be rounded with a radius not less than 1.5 times the thickness or 12 mm whichever is greater; and
c) The distance between the edge of the part and edge of the slot or hole or between adjacent slots and/or holes not to be less than twice the thickness when measured along the direction of stress and five times the thickness when measured normal to the direction of stress.

9 LAP JOINTS

9.1 The minimum overlap or parts in stress carrying lap joints shall be four times the thickness of the thinner part. Unless opening out of the parts is prevented, they shall be connected by at least two transverse or two longitudinal fillet welds.

9.2 If longitudinal fillet welds are used alone in lap joints of end connections, the length of each fillet weld shall be not less than the perpendicular distance between them. The transverse spacing of longitudinal fillet welds used in end connections shall not exceed 16 times the thickness of the thinner part connected. The longitudinal fillet welds may be in slots in addition to those along the edges, to comply with this provision.

10 PLUG WELDS

Plug welds shall not normally be provided and in any case shall not be designated to carry stresses.

11 WELDING PROCEDURE

11.1 The welding procedure shall be as given in IS 9595. A typical welding procedure qualification sheet is given in Annex A (*see also* Annex E of IS 9595).

11.2 Approval and Testing of Welding Procedures

11.2.1 If so required by the customer, the contractor shall carry out procedure tests in accordance with IS 7307(Part 1) to demonstrate by means of a specimen weld of adequate length on a steel representative of that to be used, that he can make satisfactory welds with the welding procedure to be used on the contract.

11.2.1.1 After welding, but before the relevant test given in IS 7307(Part 1) are carried out, the test weld shall be held as long as possible at room temperature, but in any case not less than 72 h, and shall then be examined for cracking.

11.3 Approval and Testing of Welders

11.3.1 The contractor shall satisfy the customer that the welders are suitable for the work upon which they shall be employed. For this purpose, the welder shall have satisfied the relevant requirements of IS 7310 (Part 1).

12 WELDING IN SOLID WEB GIRDERS

12.1 Flange Plates

12.1.1 Each flange shall as far as possible, particularly in dynamically loaded structures consist of a single section rather than of two or more sections super imposed. The single section may comprise a series of sections laid end to end and effectively welded at their junctions.

12.1.1.1 When a tension flange consists of several flange plates built up and connected to each other by welds at their edges, an outer flange plate should not be thicker than an inner plate and the above provision should be satisfied for all flange plates.

12.1.2 In dynamically loaded structures, flange plates laid end to end shall be joined by butt welds, and welded cover plates shall not be used. Joints in flange plates shall be butt welded and dressed flush before assembly.

12.2 Web Plates

12.2.1 Splice in the webs of plate girders and rolled sections used as beam shall be made by butt welds dressed flush on all faces, in the case of dynamically loaded structures.

12.3 Intermediate Stiffeners

12.3.1 Where intermediate stiffeners are connected to the web by intermittent fillet welds placed in pairs, one weld on either side of the stiffeners, the effective length of each weld shall be not less than four times the thickness of the stiffener, subject to a minimum of 40 mm.

12.3.2 Where staggered intermediate fillet welds are used, the effective length of each weld shall be not less than 10 times the thickness of the stiffener, subject to a minimum of 40 mm.

12.3.3 Fillet welds placed on one side only of the stiffener shall not be used.

12.3.4 Intermediate stiffeners carrying cross bracings or diaphragms shall not be connected to the web by intermittent fillet welds.

13 SPECIAL PRECAUTIONS IN WELDING

13.1 Sequence of welding shall be so chosen as to minimize locked up stresses, for example by welding from centre outwards.

13.2 Heavy restraint at joints may cause undue locked up stresses and hence should be avoided.

13.3 Where butt welds are specified to be ground flush with the surface of the member, adequate reinforcement should be built up and then chipped and ground flush, the grinding being done in the direction of the stress flow till all transverse marks are eliminated.

13.4 Fillet welds shall not be stopped at corners, but shall be returned round them.

13.5 Defective welds shall be chipped out before final welding.

13.6 Craters shall be properly filled up.

13.7 Procedure of welding shall ensure avoidance of vertical and overhead welding as far as practicable, where it is unavoidable, it shall be restricted to unimportant joints.

13.8 All the members/joints shall be properly identified and proper records maintained of such identification.

14 STRENGTHENING OF EXISTING BRIDGES

All provisions of this standard shall apply equally to strengthening of existing welded bridges subject to the parent metal being of weldable quality and welding shall not have any adverse effect on the structures.

Table 1 Values of f and N for Fluctuating Stresses — Class A Constructional Details

(*Clauses* 5.2.2, 5.3.1, 5.3.2 *and* 5.4)

N / $\frac{f_{Min}}{f_{Max}}$	f or f_{Max} Tensile, MPa					f or f_{Max} Compressive, MPa				
	10^5 cycles	6×10^5 cycles	2×10^6 cycles	10^7 cycles	10^8 cycles	10^5 cycles	6×10^5 cycles	2×10^6 cycles	10^7 cycles	10^8 cycles
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1.0	432.4	432.4	432.4	432.4	432.4	–	–	–	–	–
0.9	403.3	393.2	386.1	376.3	361.7	–	–	–	–	–
0.8	377.9	360.5	348.7	333.1	310.9	–	–	–	–	–
0.7	355.5	332.8	318.0	298.8	272.6	–	–	–	–	–
0.6	335.6	309.0	292.2	270.9	242.7	–	–	–	–	–
0.5	317.8	288.5	270.3	247.7	218.7	–	–	–	–	–
0.4	294.3	267.1	250.3	229.4	202.5	–	–	–	–	–
0.3	274.0	248.7	233.0	213.6	188.5	–	–	–	–	–432.4
0.2	256.3	232.7	218.0	199.8	176.4	–	–432.4	–432.4	–432.4	–390.5
0.1	240.8	218.6	204.8	187.7	165.7	–432.4	–412.1	–386.1	–353.9	–312.4
0.0	227.0	206.1	193.1	177.0	156.2	–378.3	–343.4	–321.8	–294.9	–260.4
–0.1	214.2	194.4	182.1	166.9	147.4	–324.3	–294.4	–275.8	–252.8	–223.2
–0.2	202.7	184.0	172.4	158.0	139.5	–283.8	–257.6	–241.3	–221.2	–195.3
–0.3	192.4	174.6	163.6	150.0	132.4	–252.2	–228.9	–214.5	–196.6	–173.6
–0.4	183.1	166.2	155.7	142.7	126.0	–227.0	–206.1	–193.1	–177.0	–156.2
–0.5	174.6	158.5	148.5	136.1	120.2	–206.4	–187.3	–175.5	–160.9	–142.0
–0.6	166.9	151.5	142.0	130.1	114.9	–189.2	–171.7	–160.9	–147.5	–130.2
–0.7	159.9	145.1	136.0	124.6	110.0	–174.6	–158.5	–148.5	–136.1	–120.2
–0.8	153.4	139.2	130.4	119.6	105.6	–162.1	–147.2	–137.9	–126.4	–111.6
–0.9	147.4	133.8	125.4	114.9	101.4	–151.3	–137.4	–128.7	–118.0	–104.1
–1.0	141.9	128.8	120.7	110.6	97.6	–141.9	–128.8	–120.7	–110.6	– 97.6

NOTES

1 The ratio of f_{Min}/f_{Max} is positive or negative respectively if the maximum and minimum stresses are of like or unlike sign.

2 The value given above include the maximum working stresses for all steels including those of strength higher than that conforming to IS 8500.

Table 2 Values of f and N for Fluctuating Stresses — Class B Constructional Details
(*Clauses* 5.2.2, 5.3.1, 5.3.2 *and* 5.4)

N / $\frac{f_{Min}}{f_{Max}}$ (1)	f or f_{Max} Tensile, MPa					f or f_{Max} Compressive, MPa				
	10^5 cycles (2)	6×10^5 cycles (3)	2×10^6 cycles (4)	10^7 cycles (5)	10^8 cycles (6)	10^5 cycles (7)	6×10^5 cycles (8)	2×10^6 cycles (9)	10^7 cycles (10)	10^8 cycles (11)
1.0	432.4	432.4	432.4	432.4	432.4	–	–	–	–	–
0.9	401.2	383.9	371.6	354.4	328.4	–	–	–	–	–
0.8	374.2	345.2	325.8	300.2	264.7	–	–	–	–	–
0.7	350.6	313.6	290.1	260.4	221.7	–	–	–	–	–
0.6	329.8	287.3	261.4	229.9	190.7	–	–	–	–	–
0.5	311.4	265.0	237.9	205.8	167.3	–	–	–	–	–
0.4	288.3	245.4	220.2	190.6	154.9	–	–	–	–	–432.4
0.3	268.4	228.5	205.0	177.4	144.2	–	–	–432.4	–432.4	–398.4
0.2	251.1	213.7	191.8	166.0	134.9	–	–432.4	–424.7	–367.5	–298.8
0.1	235.9	200.8	180.2	155.9	126.8	–432.4	–378.6	–339.8	–294.0	–239.0
0.0	222.4	189.3	169.9	147.0	119.5	–370.7	–315.5	–283.1	–245.0	–199.2
–0.1	209.8	178.6	160.3	138.7	112.7	–317.7	–270.4	–242.7	–210.0	–170.7
–0.2	198.6	169.0	151.7	131.3	106.7	–278.0	–236.6	–212.3	–183.8	–149.4
–0.3	188.5	160.4	144.0	124.6	101.3	–247.1	–210.3	–188.8	–163.3	–132.8
–0.4	179.4	152.7	137.0	118.6	96.4	–222.4	–189.3	–169.9	–147.0	–119.5
–0.5	171.1	145.6	130.7	113.1	91.9	–202.2	–172.1	–154.4	–133.6	–108.7
–0.6	163.5	139.2	124.9	108.1	87.9	–185.3	–157.8	–141.6	–122.5	– 99.6
–0.7	156.6	133.3	119.6	103.5	84.2	–171.1	–145.6	–130.7	–113.1	– 91.9
–0.8	150.3	127.9	114.8	99.3	80.8	–158.9	–135.2	–121.4	–105.0	– 85.4
–0.9	144.4	122.9	110.3	95.5	77.6	–148.3	–126.2	–113.3	– 98.0	– 79.7
–1.0	139.0	118.3	106.2	91.9	74.7	–139.0	–118.3	–106.2	– 91.9	– 74.7

NOTES

1 The ratio of f_{Min}/f_{Max} is positive or negative respectively if the maximum and minimum stresses are of like or unlike sign.

2 The value given above include the maximum working stresses for all steels including those of strength higher than that conforming to IS 8500.

Table 3 Values of f and N for Fluctuating Stresses — Class C Constructional Details

(*Clauses* 5.2.2, 5.3.1, 5.3.2 *and* 5.4)

N / $\frac{f_{Min}}{f_{Max}}$	f or f_{Max} Tensile, MPa					f or f_{Max} Compressive, MPa				
	10^5 cycles	6×10^5 cycles	2×10^6 cycles	10^7 cycles	10^8 cycles	10^5 cycles	6×10^5 cycles	2×10^6 cycles	10^7 cycles	10^8 cycles
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1.0	432.4	432.4	432.4	432.4	432.4	–	–	–	–	–
0.9	400.9	378.6	362.5	339.7	305.4	–	–	–	–	–
0.8	373.7	336.7	312.0	279.8	236.1	–	–	–	–	–
0.7	349.9	303.1	273.9	237.8	192.4	–	–	–	–	–
0.6	329.0	275.6	244.1	206.8	162.4	–	–	–	–	–
0.5	310.4	252.7	220.1	182.9	140.4	–	–	–	–	–
0.4	282.2	229.7	200.1	166.3	127.7	–	–	–	–432.4	–432.4
0.3	258.7	210.6	183.4	152.5	117.0	–	–432.4	–432.4	–406.5	–312.1
0.2	238.8	194.4	169.3	140.7	108.0	–432.4	–421.2	–366.8	–304.9	–234.1
0.1	221.7	180.5	157.2	130.7	100.3	–413.9	–336.9	–293.4	–243.9	–187.3
0.0	207.0	168.5	146.7	122.0	93.6	–344.9	–280.8	–244.5	–203.3	–156.1
–0.1	195.2	158.9	138.4	115.1	88.3	–295.6	–240.7	–209.6	–174.2	–133.8
–0.2	184.8	150.4	131.0	108.9	83.6	–258.7	–210.6	–183.4	–152.4	–117.0
–0.3	175.4	142.8	124.3	103.4	79.4	–230.0	–187.2	–163.2	–135.5	–104.0
–0.4	166.9	135.9	118.3	98.4	75.5	–207.0	–168.5	–146.7	–122.0	– 93.6
–0.5	159.2	129.6	112.9	93.8	72.0	–188.1	–153.2	–133.4	–110.9	– 85.1
–0.6	152.2	123.9	107.9	89.7	68.9	–172.5	–140.4	–122.3	–101.6	– 78.0
–0.7	145.7	118.6	103.3	85.9	65.9	–150.2	–129.6	–112.9	– 93.9	– 72.0
–0.8	139.8	113.8	99.1	82.4	63.3	–147.8	–120.3	–104.8	– 87.1	– 66.9
–0.9	134.4	109.4	95.3	79.2	60.8	–138.0	–112.3	– 97.8	– 81.3	– 62.4
–1.0	129.3	105.3	91.7	76.2	85.5	–129.3	–105.3	– 91.7	– 76.2	– 58.5

NOTES

1 The ratio of f_{Min}/f_{Max} is positive or negative respectively if the maximum and minimum stresses are of like or unlike sign.

2 The value given above include the maximum working stresses for all steels including those of strength higher than that conforming to IS 8500.

Table 4 Values of f and N for Fluctuating Stresses — Class D Constructional Details
(*Clauses* 5.2.2, 5.3.1, 5.3.2 *and* 5.4)

N / $\frac{f_{Min}}{f_{Max}}$	f or f_{Max} Tensile, MPa					f or f_{Max} Compressive, MPa				
(1)	10^5 cycles (2)	6×10^5 cycles (3)	2×10^6 cycles (4)	10^7 cycles (5)	10^8 cycles (6)	10^5 cycles (7)	6×10^5 cycles (8)	2×10^6 cycles (9)	10^7 cycles (10)	10^8 cycles (11)
1.0	432.4	432.4	432.4	432.4	432.4	–	–	–	–	–
0.9	392.7	367.3	349.0	323.2	284.7	–	–	–	–	–
0.8	359.7	319.2	292.5	258.0	212.2	–	–	–	–	–
0.7	331.8	282.3	251.8	214.7	169.1	–	–	–	–	–
0.6	307.9	253.0	221.0	183.9	140.6	–	–	–	–	–
0.5	287.3	229.2	196.9	160.8	120.3	–	–	–	–	–432.4
0.4	261.1	208.4	179.0	146.1	109.3	–	–	–	–432.4	–400.9
0.3	239.4	191.0	164.1	134.0	100.2	–	–432.4	–432.4	–357.2	–267.2
0.2	221.0	176.3	151.5	123.7	92.5	–432.4	–382.0	–328.2	–267.9	–200.4
0.1	205.2	163.7	140.7	114.8	85.9	–383.0	–305.6	–262.6	–214.3	–160.3
0.0	191.5	152.8	131.3	107.2	80.2	–319.2	–254.7	–218.8	–178.6	–133.6
–0.1	180.7	144.1	123.9	101.1	75.6	–273.6	–218.3	–187.5	–153.1	–114.5
–0.2	171.0	136.4	117.2	95.7	71.6	–239.4	–191.0	–164.1	–134.0	–100.2
–0.3	162.3	129.5	111.3	90.9	68.0	–212.8	–169.8	–145.9	–119.1	– 89.1
–0.4	154.4	123.2	105.9	86.4	64.7	–191.5	–152.8	–131.3	–107.2	– 80.2
–0.5	147.3	117.5	101.0	82.0	61.7	–174.1	–138.9	–119.3	– 97.4	–72.9
–0.6	140.8	112.3	96.5	78.8	59.0	–159.6	–127.3	–109.4	– 89.3	–66.8
–0.7	134.9	107.6	92.4	75.5	56.5	–147.3	–117.5	–101.0	– 82.4	–61.7
–0.8	129.4	103.2	88.7	72.4	54.2	–136.8	–109.1	– 93.8	– 76.6	– 57.3
–0.9	124.4	99.2	85.2	69.6	52.1	–127.7	–101.9	– 87.5	– 71.5	– 53.5
–1.0	119.7	95.5	82.1	67.0	50.1	–119.7	– 95.5	– 82.1	– 67.0	– 50.1

NOTES

1 The ratio of f_{Min}/f_{Max} is positive or negative respectively if the maximum and minimum stresses are of like or unlike sign.

2 The value given above include the maximum working stresses for all steels including those of strength higher than that conforming to IS 8500.

Table 5 Values of f and N for Fluctuating Stresses — Class E Constructional Details
(*Clauses* 5.2.2, 5.3.1, 5.3.2 *and* 5.4)

N → / f_{Min}/f_{Max} ↓	f or f_{Max} Tensile, MPa					f or f_{Max} Compressive, MPa				
	10^5 cycles	6×10^5 cycles	2×10^6 cycles	10^7 cycles	10^8 cycles	10^5 cycles	6×10^5 cycles	2×10^6 cycles	10^7 cycles	10^8 cycles
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1.0	432.4	432.4	432.4	432.4	432.4*	–	–	–	–	–
0.9	383.7	348.5	323.1	287.6	236.0	–	–	–	–	–
0.8	344.8	291.9	257.9	215.4	162.3	–	–	–	–	–
0.7	313.1	251.1	214.6	172.2	123.7	–	–	–	–	–
0.6	286.7	220.3	183.7	143.4	99.9	–	–	–	–	–
0.5	264.4	196.2	160.6	122.9	83.8	–	–	–	–432.4	–432.4
0.4	236.1	175.2	143.4	109.7	74.8	–	–432.4	–432.4	–384.0	–261.8
0.3	213.2	158.3	129.5	99.1	67.6	–432.4	–408.8	–334.6	–256.0	–174.5
0.2	194.4	144.3	118.1	90.4	61.6	–413.1	–306.6	–251.0	–192.0	–130.9
0.1	178.7	132.6	108.5	83.0	56.6	–330.5	–245.3	–200.8	–153.6	–104.7
0.0	165.3	122.7	100.4	76.8	52.4	–275.4	–204.4	–167.3	–128.0	– 87.3
–0.1	155.9	115.7	94.7	72.5	49.4	–236.1	–175.2	–143.4	–109.7	– 74.8
–0.2	147.6	109.5	89.6	68.6	46.8	–206.6	–153.3	–125.5	– 96.0	– 65.5
–0.3	140.0	103.9	85.1	65.1	44.4	–183.6	–136.3	–111.6	– 85.3	– 58.2
–0.4	133.3	98.9	81.0	61.9	42.2	–165.3	–122.7	–100.4	– 76.8	– 52.4
–0.5	127.1	94.4	77.2	59.1	40.3	–150.2	–111.5	– 91.3	– 69.8	– 47.6
–0.6	121.5	90.2	73.8	56.5	38.5	–137.7	–102.2	– 83.7	– 64.0	– 43.6
–0.7	116.4	86.4	70.7	54.1	36.9	–127.1	– 94.4	– 77.2	– 59.1	– 40.3
–0.8	111.7	82.9	67.8	51.9	35.4	–118.0	– 87.6	– 71.7	– 54.9	– 37.4
–0.9	107.3	79.7	65.2	49.9	34.0	–110.2	– 81.8	– 66.9	– 51.2	– 34.9
–1.0	103.3	76.7	62.7	48.0	32.7	–103.3	– 76.7	– 62.7	– 48.0	– 32.7

NOTES

1 The ratio of f_{Min}/f_{Max} is positive or negative respectively if the maximum and minimum stresses are of like or unlike sign.

2 The value given above include the maximum working stresses for all steels including those of strength higher than that conforming to IS 8500.

Table 6 Values of f and N for Fluctuating Stresses — Class F Constructional Details

(*Clauses* 5.2.2, 5.3.1, 5.3.2 *and* 5.4)

N / $\frac{f_{Min}}{f_{Max}}$	f or f_{Max} Tensile, MPa					f or f_{Max} Compressive, MPa				
	10^5 cycles	6×10^5 cycles	2×10^6 cycles	10^7 cycles	10^8 cycles	10^5 cycles	6×10^5 cycles	2×10^6 cycles	10^7 cycles	10^8 cycles
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1.0	432.4	432.4	432.4	432.4	432.4	–	–	–	–	–
0.9	377.1	330.3	296.4	250.0	190.9	–	–	–	–	–
0.8	334.3	267.3	225.5	175.8	122.5	–	–	–	–	–
0.7	300.2	224.4	182.0	135.6	90.2	–	–	–	–	–
0.6	272.5	193.4	152.5	110.3	71.3	–	–	–	–432.4	–432.4
0.5	249.4	169.9	131.3	93.0	59.0	–	–432.4	–432.4	–382.2	–200.4
0.4	218.8	149.0	115.2	81.6	50.9	–432.4	–374.8	–289.6	–205.1	–125.2
0.3	194.9	132.7	102.5	72.7	44.7	–400.1	–272.5	–210.5	–149.2	– 91.1
0.2	175.7	119.7	92.5	65.5	40.0	–314.4	–214.2	–165.5	–117.2	– 71.6
0.1	159.9	108.9	84.2	59.6	36.4	–258.9	–176.4	–136.3	– 96.5	– 58.9
0.0	146.7	99.9	77.2	54.7	33.4	–220.1	–149.9	–115.8	– 82.1	– 50.1
–0.1	137.5	93.7	72.4	51.3	31.3	–191.4	–130.4	–100.7	– 71.4	– 43.6
–0.2	129.5	88.2	68.1	48.3	29.5	–169.3	–115.3	– 89.1	– 63.1	– 38.5
–0.3	122.3	83.3	64.4	45.6	27.8	–151.8	–103.4	– 80.0	– 56.6	– 34.6
–0.4	115.8	78.9	61.0	43.2	26.4	–137.6	– 93.7	– 72.4	– 51.3	– 31.3
–0.5	110.0	75.0	57.9	41.0	25.1	–125.8	– 85.7	– 66.2	– 46.9	– 28.6
–0.6	104.8	71.4	55.2	39.1	23.9	–115.8	– 78.9	– 61.0	– 43.2	– 26.4
–0.7	100.0	68.1	52.7	37.3	22.8	–107.4	– 73.1	– 56.5	– 40.0	– 24.4
–0.8	95.7	65.2	50.4	35.7	21.8	–100.0	– 68.1	– 52.7	– 37.3	– 22.8
–0.9	91.7	62.5	48.3	34.2	20.9	– 93.7	– 63.8	– 49.3	– 34.9	– 21.3
–1.0	88.0	60.0	46.3	32.8	20.0	– 88.0	– 60.0	– 46.3	– 32.8	– 20.0

NOTES

1 The ratio of f_{Min}/f_{Max} is positive or negative respectively if the maximum and minimum stresses are of like or unlike sign.

2 The value given above include the maximum working stresses for all steels including those of strength higher than that conforming to IS 8500.

Table 7 Values of f and N for Fluctuating Stresses — Class G Constructional Details

(*Clauses* 5.2.2, 5.3.1, 5.3.2 *and* 5.5)

N / $\frac{f_{Min}}{f_{Max}}$	f or f_{Max} Tensile, MPa					f or f_{Max} Compressive, MPa				
	10^5 cycles	6×10^5 cycles	2×10^6 cycles	10^7 cycles	10^8 cycles	10^5 cycles	6×10^5 cycles	2×10^6 cycles	10^7 cycles	10^8 cycles
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1.0	432.4	432.4	432.4	432.4	432.4	–	–	–	–	–
0.9	356.0	292.6	248.1	190.9	190.9	–	–	–	–	–
0.8	302.5	221.1	174.0	122.5	122.5	–	–	–	–	–
0.7	263.0	177.7	134.0	90.2	90.2	–	–	–	–	–
0.6	232.6	148.5	108.9	71.3	71.3	–	–432.4	–366.3	–235.7	–235.7
0.5	208.5	127.6	91.7	59.0	59.0	–432.4	–296.4	–213.1	–137.1	–137.1
0.4	179.7	110.0	79.1	50.9	50.9	–341.6	–209.0	–150.3	– 96.7	– 96.7
0.3	158.0	96.7	69.5	44.7	44.7	–263.8	–161.4	–116.1	– 74.7	– 74.7
0.2	140.9	86.2	62.0	39.9	39.9	–214.9	–131.5	– 94.5	– 60.8	– 60.8
0.1	127.1	77.8	55.9	36.0	36.0	–181.2	–110.9	– 79.7	– 51.3	– 51.3
0.0	115.8	70.9	51.0	32.8	32.8	–156.7	– 95.9	– 69.0	– 44.4	– 44.4
–0.1	107.9	66.0	47.5	30.5	30.5	–138.0	– 84.5	– 60.7	– 39.1	– 39.1
–0.2	100.9	61.8	44.4	28.6	28.6	–123.3	– 75.5	– 54.3	– 34.9	– 34.9
–0.3	94.8	58.0	41.7	26.8	26.8	–111.5	– 68.2	– 49.1	– 31.6	– 31.6
–0.4	89.4	54.7	39.3	25.3	25.3	–101.7	– 62.2	– 44.7	– 28.8	– 28.8
–0.5	84.6	51.8	37.2	23.9	23.9	– 93.5	– 57.2	– 41.1	– 26.5	– 26.5
–0.6	80.2	49.1	35.3	22.7	22.7	– 86.5	– 53.0	– 38.1	– 24.5	– 24.5
–0.7	76.3	46.7	33.6	21.6	21.6	– 80.5	– 49.3	– 35.4	– 22.8	– 22.8
–0.8	72.8	44.6	32.0	20.6	20.6	– 75.3	– 46.1	– 33.1	– 21.3	– 21.3
–0.9	69.5	42.6	30.6	19.7	19.7	– 70.7	– 43.3	– 31.1	– 20.0	– 20.0
–1.0	66.6	40.8	29.3	18.9	18.9	– 66.6	– 40.8	– 29.3	– 18.9	– 18.9

NOTES

1 The ratio of f_{Min}/f_{Max} is positive or negative respectively if the maximum and minimum stresses are of like or unlike sign.

2 The value given above include the maximum working stresses for all steels including those of strength higher than that conforming to IS 8500.

Table 8 Minimum Size of First Run of a Fillet Weld

(*Clauses* 8.4.3 *and* 8.5.4)

Thickness of Thicker Part		Size of Fillet Weld
Over	Up to and Including	
mm	mm	mm
(1)	(2)	(3)
–	6	3
6	12	4
12	18	6
18	36	8
36	56	10
56	150	12
150	–	16

ANNEX A

(*Clause* 11.1)

TYPICAL WELDING PROCEDURE DATA SHEET

Specification No. ....Date..

Welding Process...Manual or Machine...

Material Specification:Grade...................... of IS. .... Batch/Cast No. ....

Thickness ....

Filler Metal Specification...

Weld Metal Analysis..

FLUX OR SHIELDING GAS

Flux Trade Name or Composition..

Inert Gas Composition..

Trade Name....................................... Flow Rate...

Is Backing Strip Used?...

Preheat Temperature Range..

Interpass Temperature Range...

Postheat Treatment...

WELDING PROCEDURE

Single or Multiple Pass...

Single or Multiple Arc..

Welding Position(s)..

FOR INFORMATION ONLY

Electrode/Filler Wire Diameter...

Trade Name..

Type of Backing...

Forehand or Backhand...

WELDING TECHNIQUES

Joint Details..

Amps......................................Volts...

Electrode Consumed (cm/m)..

Current..................................Polarity...

Size of Reinforcement.........................Whether Removed..

Inspection and Test Schedules..

Signature